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(54) **PRINTING MACHINE**

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(51) **Int. Cl.**

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| ***B41J 11/00*** | (2006.01) |
| ***B41J 13/00*** | (2006.01) |
| ***B65H 5/22*** | (2006.01) |
| ***B65H 7/02*** | (2006.01) |
| *B65H 29/24* | (2006.01) |

(52) **U.S. Cl.**

CPC .......... ***B41J 11/0085*** (2013.01); ***B41J 13/0009*** (2013.01); ***B65H 5/224*** (2013.01); ***B65H 7/02*** (2013.01); *B65H 29/242* (2013.01); *B65H 2301/44735* (2013.01); *B65H 2406/32* (2013.01); *B65H 2406/3222* (2013.01); *B65H 2513/50* (2013.01); *B65H 2515/212* (2013.01); *B65H 2515/342* (2013.01); *B65H 2515/81* (2013.01); *B65H 2701/1311* (2013.01); *B65H 2701/1313* (2013.01)

(58) **Field of Classification Search**

CPC .................. B65H 2406/36; B65H 2406/3622; B65H 2406/3632; B65H 29/242; B65H 2301/44735; B65H 2406/3221; B65H 2406/3222; B65H 2406/32

USPC ............................................ 271/265.04, 276

See application file for complete search history.

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(57) **ABSTRACT**

A printing machine includes: a paper feed unit configured to feed a sheet of paper; a suction transfer unit configured to transfer the sheet of paper fed by the paper feed unit in a transfer direction, with the sheet of paper being attached by suction onto a transfer surface; a transfer and paper discharge unit configured to receive the sheet of paper from the suction transfer unit to transfer and discharge the sheet of paper; and a controller configured to control a suction force of the suction transfer unit in accordance with a paper type. When the controller changes the suction force of the suction transfer unit between successive sheets of paper, the controller is configured prior to a discharge of a precedent sheet of paper to change the suction force of the suction transfer unit and drive the paper feed unit to feed a subsequent sheet of paper.

**2 Claims, 8 Drawing Sheets**

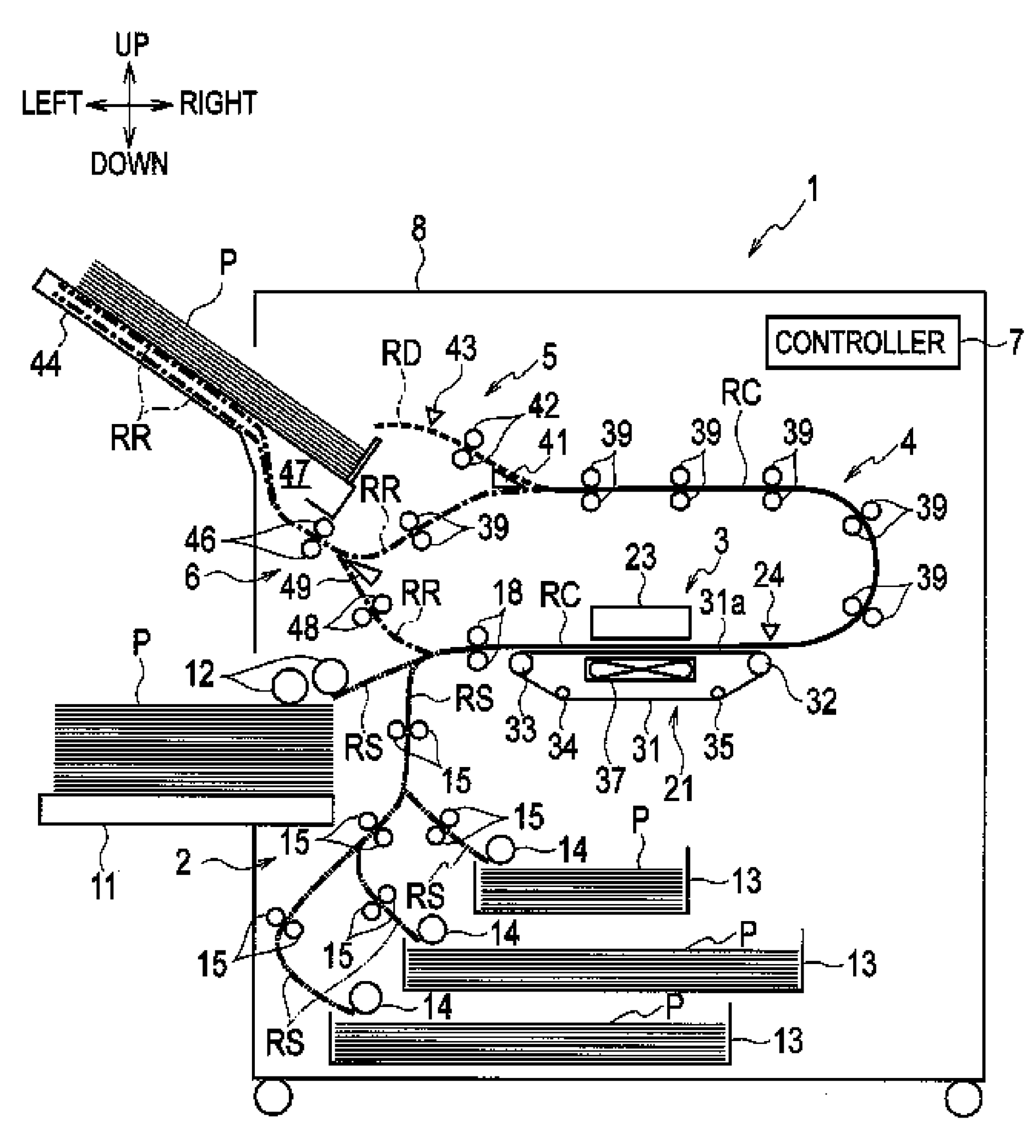


FIG. 1

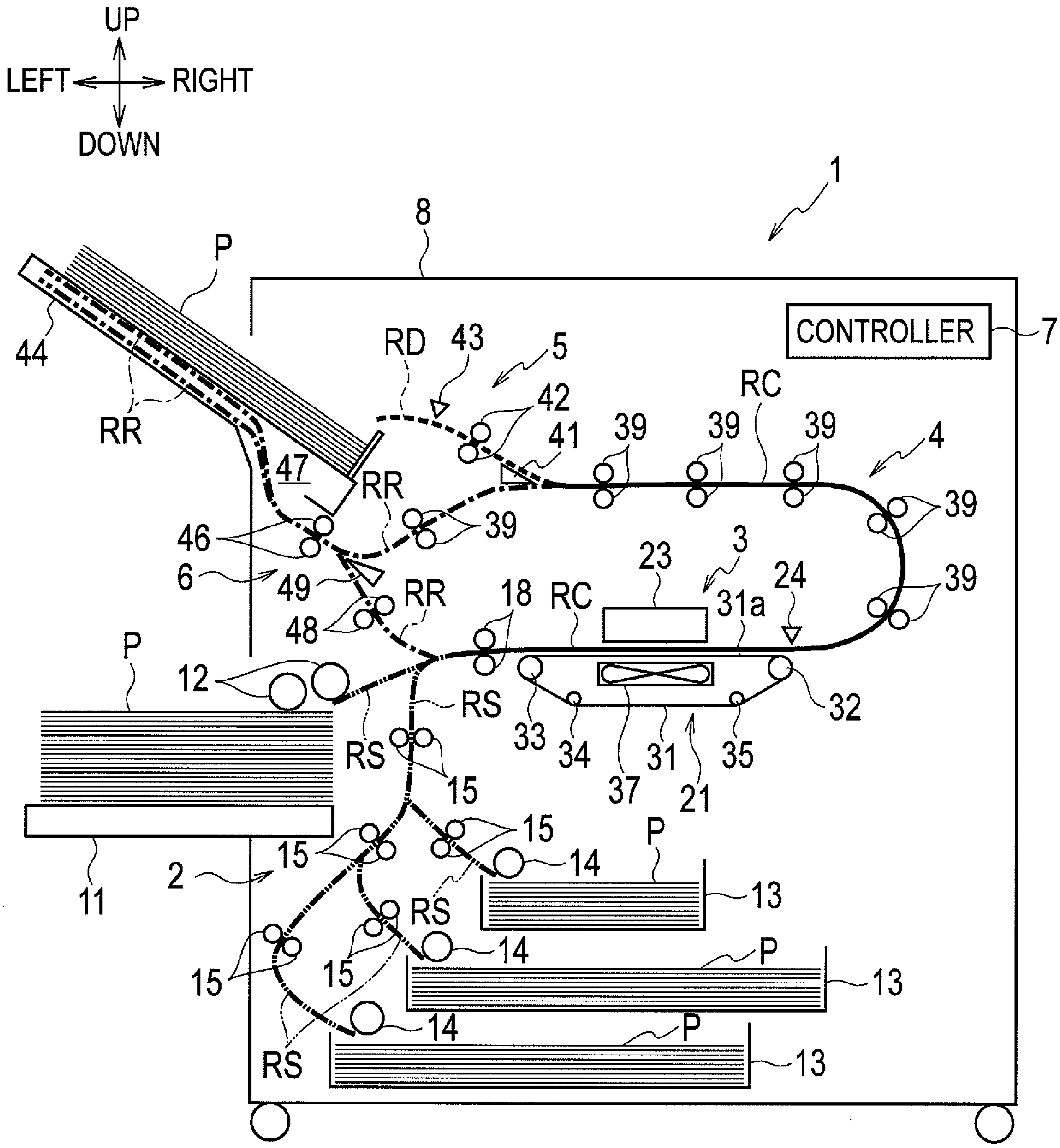

UP
LEFT
RIGHT
DOWN
1
8
P
44
RR
RD
43
5
42
41
39
RC
4
CONTROLLER
7
47
RR
46
6
49
48
RR
18
RC
23
3
24
31a
P
12
RS
RS
15
33
34
37
31
35
32
21
11
2
15
14
P
13
RS
15
15
14
P
13
RS
14
P
13

FIG. 2

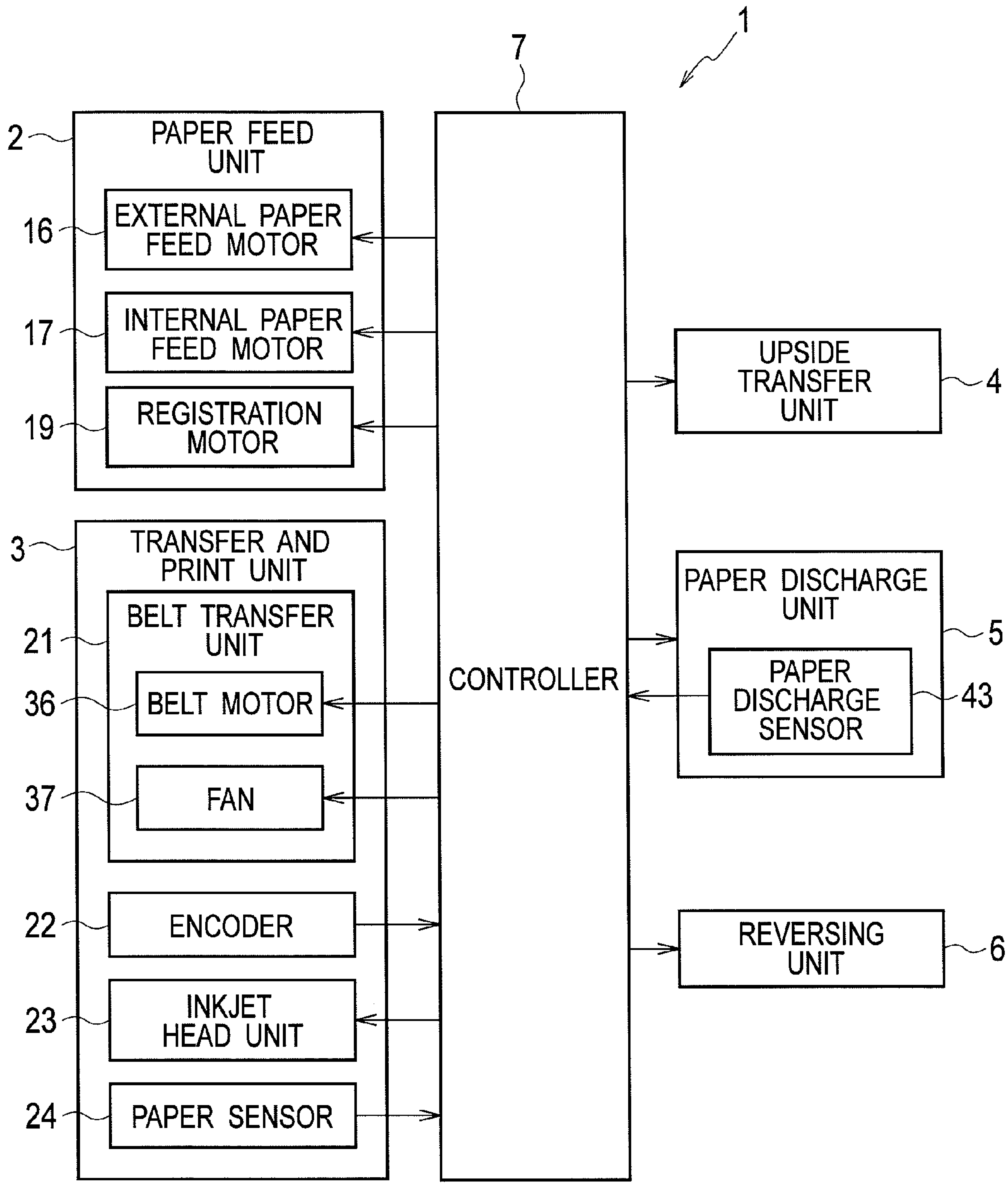

1
7
2
PAPER FEED UNIT
16
EXTERNAL PAPER FEED MOTOR
17
INTERNAL PAPER FEED MOTOR
19
REGISTRATION MOTOR
3
TRANSFER AND PRINT UNIT
21
BELT TRANSFER UNIT
36
BELT MOTOR
37
FAN
22
ENCODER
23
INKJET HEAD UNIT
24
PAPER SENSOR
CONTROLLER
UPSIDE TRANSFER UNIT
4
PAPER DISCHARGE UNIT
5
PAPER DISCHARGE SENSOR
43
REVERSING UNIT
6

FIG. 3

| PAPER TYPE | AIR FLOW RATE |
|---|---|
| ORDINARY PAPER | HIGH |
| THICK PAPER | HIGH |
| THIN PAPER | LOW |

FIG. 4

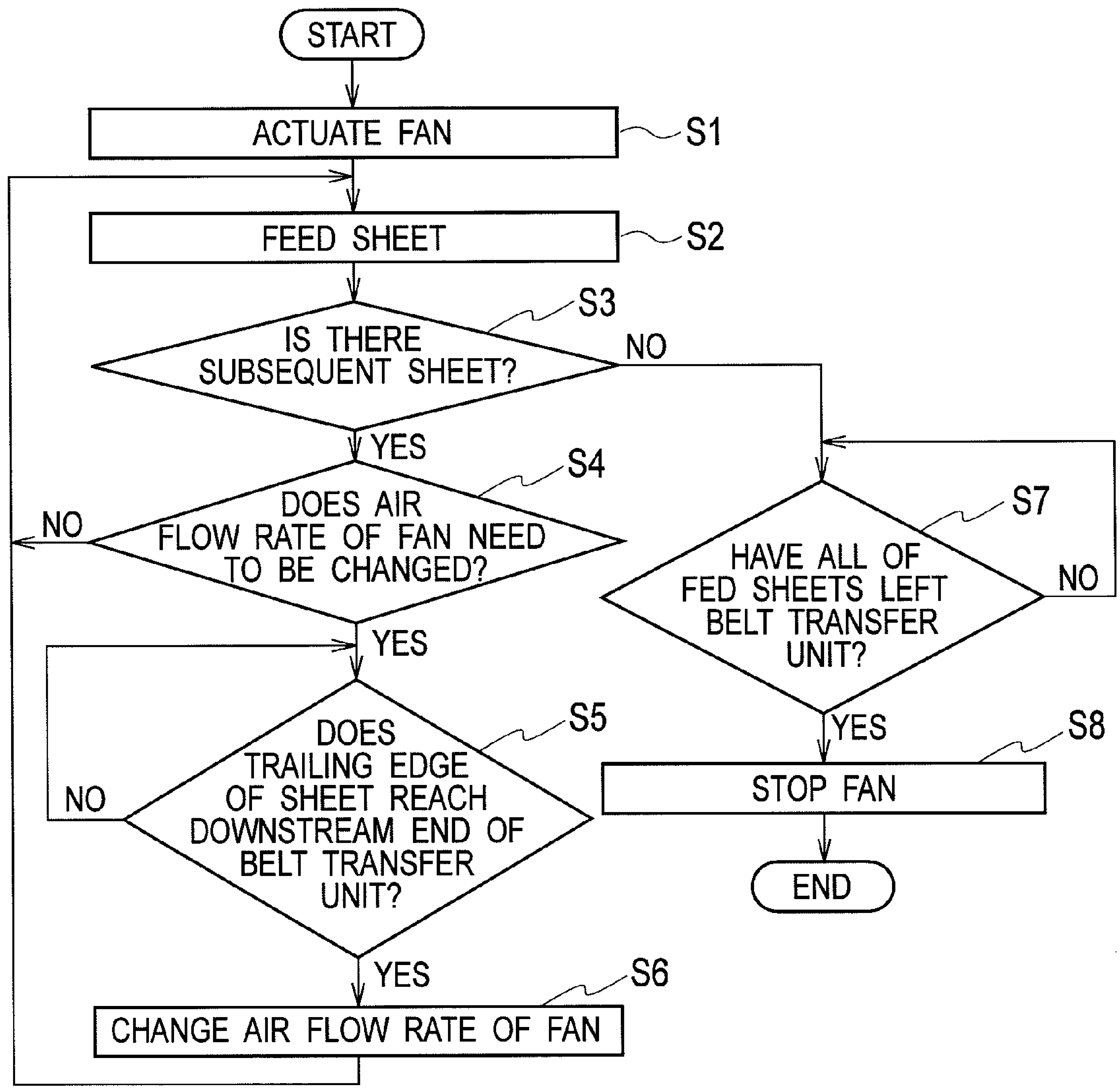


FIG. 5

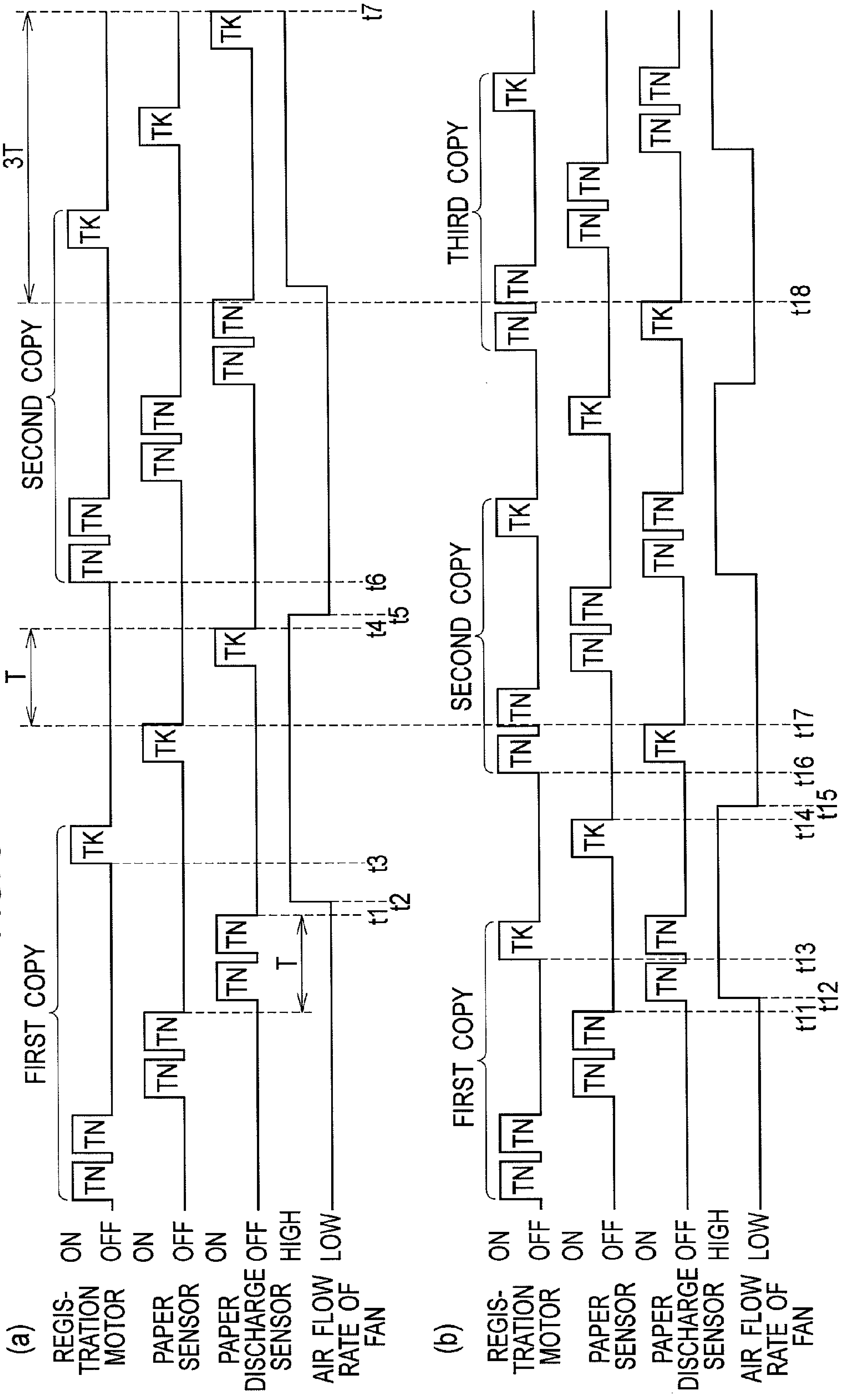

(a)
REGIS-TRATION MOTOR
ON
OFF
PAPER SENSOR
ON
OFF
PAPER DISCHARGE SENSOR
ON
OFF
AIR FLOW RATE OF FAN
HIGH
LOW
FIRST COPY
SECOND COPY
TN
TK
T
3T
t1
t2
t3
t4
t5
t6
t7
(b)
REGIS-TRATION MOTOR
PAPER SENSOR
PAPER DISCHARGE SENSOR
AIR FLOW RATE OF FAN
FIRST COPY
SECOND COPY
THIRD COPY
t11
t12
t13
t14
t15
t16
t17
t18

FIG. 6

| | PRECEDENT SHEET | | SUBSEQUENT SHEET | | CHANGE OF AIR FLOW RATE | TIMING FOR CHANGING AIR FLOW RATE |
|---|---|---|---|---|---|---|
| | PAPER TYPE | PAPER SIZE | PAPER TYPE | PAPER SIZE | | |
| 1 | ORDINARY SHEET THICK SHEET | ANY SIZE | THIN SHEET | ANY SIZE | HIGH→LOW | WHEN AMOUNT OF TRANSFER REACHES REFERENCE VALUE AFTER LEADING EDGE OF PRECEDENT SHEET REACHES DOWNSTREAM END OF BELT TRANSFER UNIT |
| 2 | THIN SHEET | LARGE SIZE | ORDINARY SHEET THICK SHEET | ANY SIZE | LOW→HIGH | WHEN TRAILING EDGE OF PRECEDENT SHEET REACHES DOWNSTREAM END OF BELT TRANSFER UNIT |
| 3 | THIN SHEET | SMALL SIZE | ORDINARY SHEET THICK SHEET | ANY SIZE | LOW→HIGH | WHEN AMOUNT OF TRANSFER REACHES REFERENCE VALUE AFTER LEADING EDGE OF PRECEDENT SHEET REACHES DOWNSTREAM END OF BELT TRANSFER UNIT |

FIG. 7

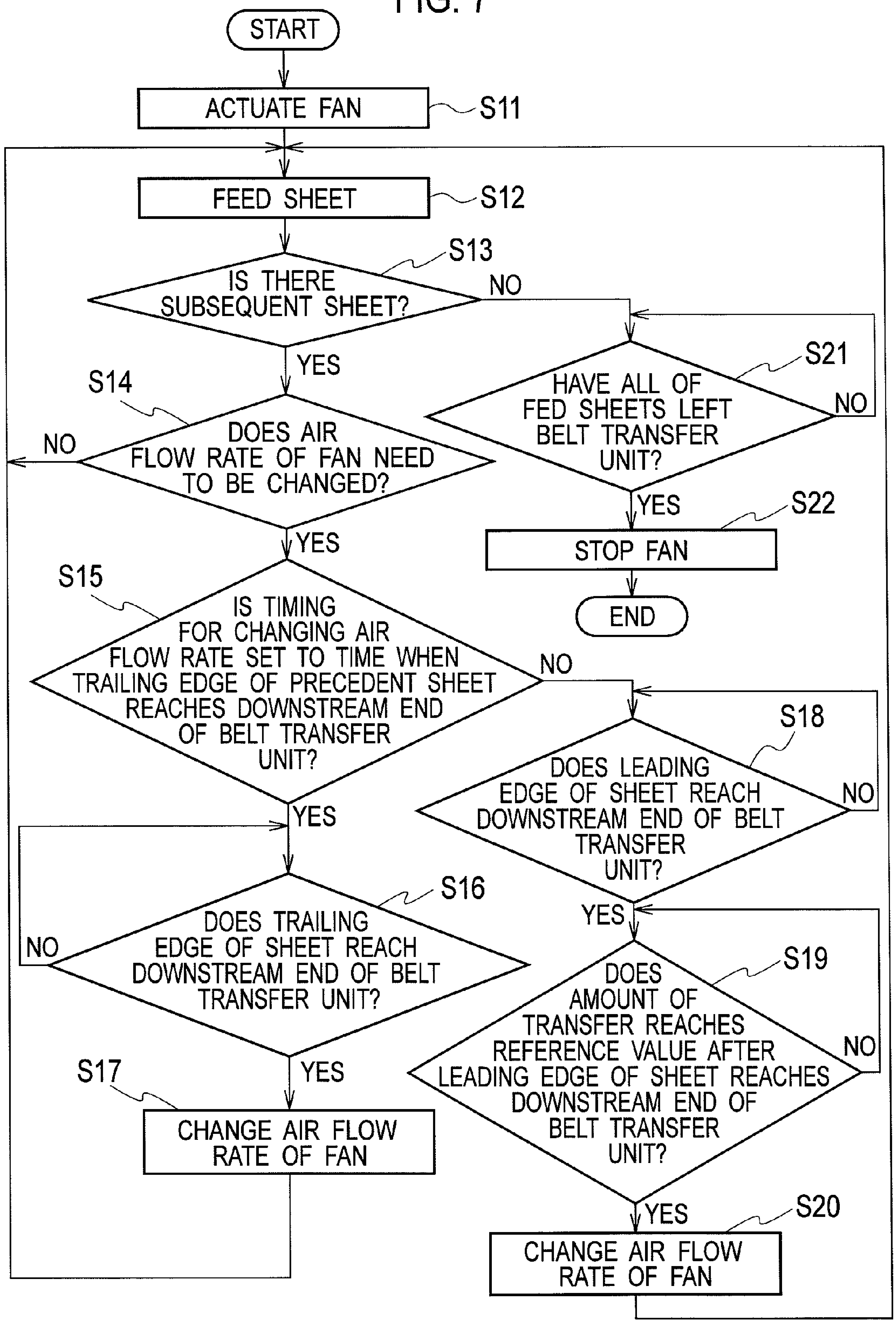

START
ACTUATE FAN
S11
FEED SHEET
S12
S13
IS THERE SUBSEQUENT SHEET?
NO
YES
S14
DOES AIR FLOW RATE OF FAN NEED TO BE CHANGED?
NO
YES
S15
IS TIMING FOR CHANGING AIR FLOW RATE SET TO TIME WHEN TRAILING EDGE OF PRECEDENT SHEET REACHES DOWNSTREAM END OF BELT TRANSFER UNIT?
NO
YES
S16
DOES TRAILING EDGE OF SHEET REACH DOWNSTREAM END OF BELT TRANSFER UNIT?
NO
YES
S17
CHANGE AIR FLOW RATE OF FAN
S21
HAVE ALL OF FED SHEETS LEFT BELT TRANSFER UNIT?
NO
YES
S22
STOP FAN
END
S18
DOES LEADING EDGE OF SHEET REACH DOWNSTREAM END OF BELT TRANSFER UNIT?
NO
YES
S19
DOES AMOUNT OF TRANSFER REACHES REFERENCE VALUE AFTER LEADING EDGE OF SHEET REACHES DOWNSTREAM END OF BELT TRANSFER UNIT?
NO
YES
S20
CHANGE AIR FLOW RATE OF FAN

FIG. 8

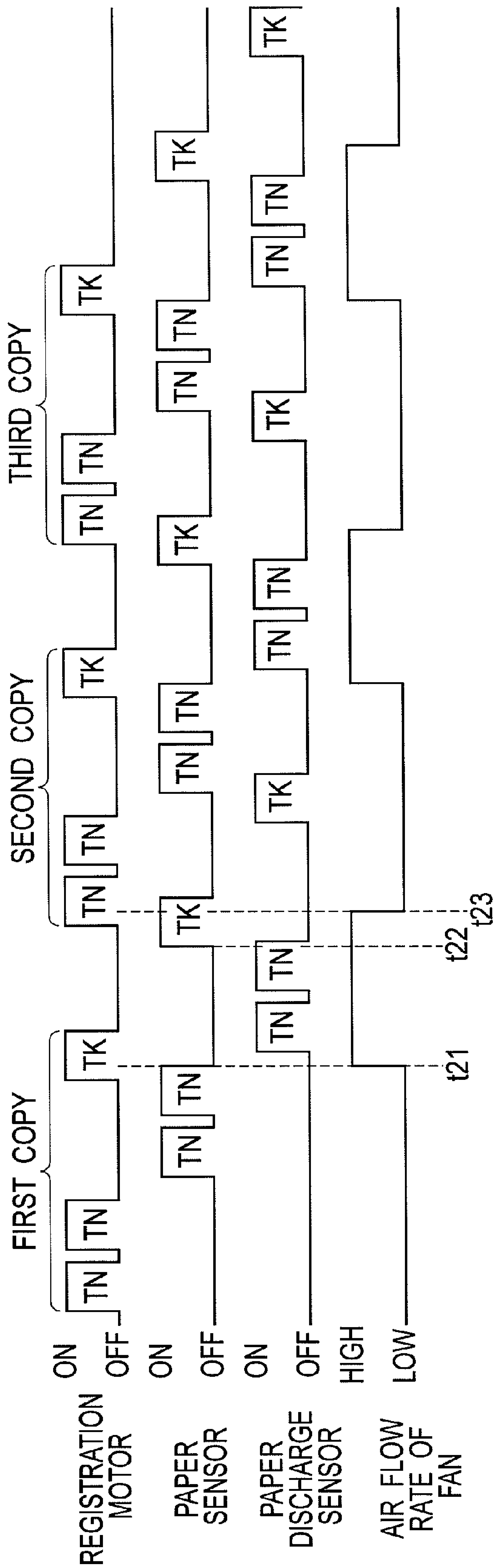
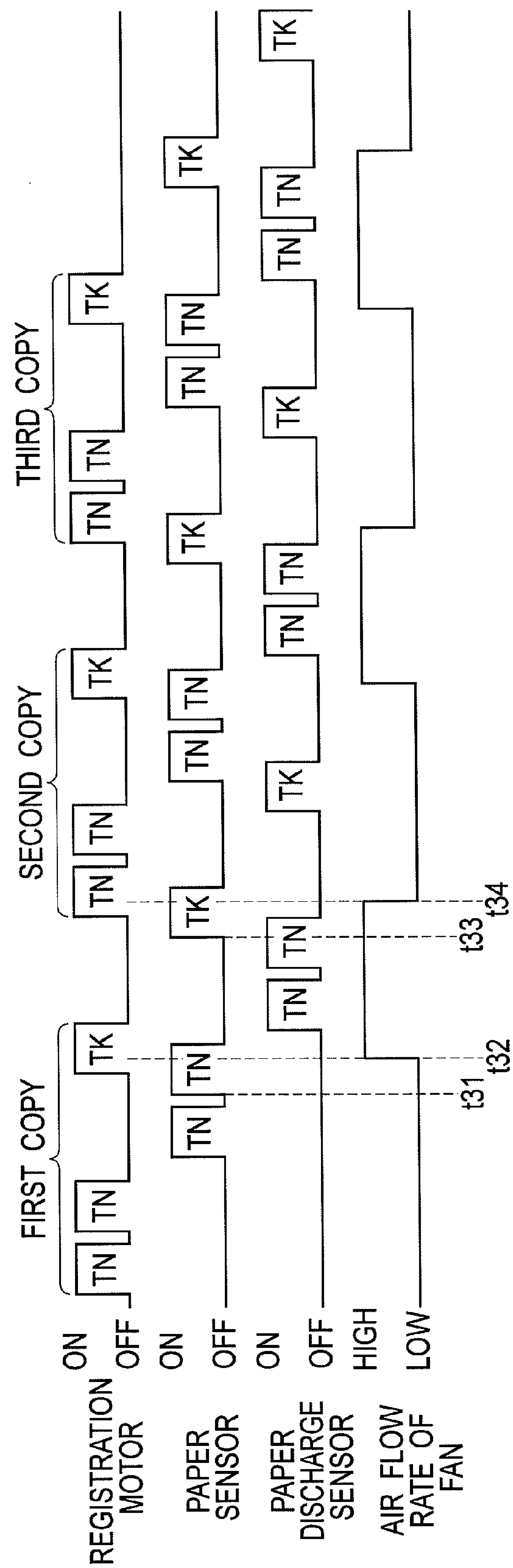

FIRST COPY
SECOND COPY
THIRD COPY
TN
TK
REGISTRATION MOTOR
PAPER SENSOR
PAPER DISCHARGE SENSOR
AIR FLOW RATE OF FAN
ON
OFF
HIGH
LOW
t21
t22
t23

FIG. 9


FIRST COPY
SECOND COPY
THIRD COPY
TN
TK
REGISTRATION MOTOR
PAPER SENSOR
PAPER DISCHARGE SENSOR
AIR FLOW RATE OF FAN
ON
OFF
HIGH
LOW
t31
t32
t33
t34

# PRINTING MACHINE

## CROSS REFERENCE TO RELATED APPLICATION

This application is based upon and claims the benefit of priority from the prior Japanese Patent Application No. 2013-012163, filed on Jan. 25, 2013, the entire contents of which are incorporated herein by reference.

## BACKGROUND

1. Technical Field

The present invention relates to a printing machine configured to perform printing on paper.

2. Related Art

A printing machine which performs printing by ejecting ink from an inkjet head while transferring paper is described in Japanese Patent Application Publication No. 2010-149310. In order to perform printing while transferring paper, this printing machine transfers the paper as follows: the paper is attached onto a looped conveyor belt with multiple through holes by air suction using a fan, and the conveyor belt is endlessly moved.

Here, in the case where paper is attached onto a conveyor belt by air suction using a fan, the air flow rate of the fan is changed in accordance with the type of the paper in some cases. The higher the air flow rate of the fan, the stronger the suction force of the paper to the conveyor belt. For example, the air flow rate of the fan is set lower in transferring thin paper, than in transferring ordinary or thick paper. Such control of the air flow rate prevents the occurrence of wrinkles in thin paper during the transfer of the thin paper and the floating of ordinary or thick paper during the transfer of the ordinary or thick paper.

## SUMMARY

In a printing machine described above, there are cases where plural types of sheets of paper are successively printed. For example, using a binding printing function, the printing machine successively prints sheets of paper for body pages and a sheet of paper for a cover page which are different types of sheets of paper. In such printing, the air flow rate of the fan may need to be changed between different types of successive sheets.

Heretofore, in such a case, after the discharging of a precedent sheet is finished, the air flow rate of the fan is changed, and then a subsequent sheet is fed. Accordingly, every time the air flow rate of the fan is changed, a printing operation is interrupted. Thus, productivity is decreased.

An object of the present invention is to provide a printing machine which can reduce a decrease in productivity.

A printing machine in accordance with some embodiments includes: a paper feed unit configured to feed a sheet of paper; a suction transfer unit configured to transfer the sheet of paper fed by the paper feed unit in a transfer direction, with the sheet of paper being attached by suction onto a transfer surface; a transfer and paper discharge unit configured to receive the sheet of paper from the suction transfer unit to transfer and discharge the sheet of paper; and a controller configured to control a suction force of the suction transfer unit in accordance with a paper type. When the controller changes the suction force of the suction transfer unit between successive sheets of paper, the controller is configured prior to a discharge of a precedent sheet of paper to change the suction force of the suction transfer unit and drive the paper feed unit to feed a subsequent sheet of paper.

According to the above-described configuration, in the case where the suction force of the suction transfer unit is changed between successive sheets of paper, the change of the suction force by the suction transfer unit and the feed of a subsequent sheet by the paper feed unit are performed before a precedent sheet is discharged. Accordingly, a decrease in productivity can be reduced.

When the controller changes the suction force of the suction transfer unit between the successive sheets of paper, the controller may be configured to change the suction force of the suction transfer unit at a time when a trailing edge of the precedent sheet of paper reaches a downstream end of the suction transfer unit in the transfer direction.

According to the above-described configuration, the suction force of the suction transfer unit is changed at the time when the trailing edge of the precedent sheet reaches the downstream end of the suction transfer unit with respect to the transfer direction. This makes it possible to further shorten the distance between the precedent sheet and the subsequent sheet and further reduce a decrease in productivity.

When the controller changes the suction force of the suction transfer unit between the successive sheets of paper, and when the precedent sheet of paper and the subsequent sheet of paper are in a prescribed combination in the paper type and a paper size, the controller may be configured to change the suction force of the suction transfer unit in a period after a leading edge of the precedent sheet of paper reaches the downstream end of the suction transfer unit in the transfer direction and before the trailing edge of the precedent sheet of paper reaches the downstream end of the suction transfer unit.

According to the above-described configuration, in the case where the precedent sheet and the subsequent sheet are in the prescribed combination in paper type and paper size, the suction force of the suction transfer unit is changed in a period after the leading edge of the precedent sheet reaches the downstream end of the suction transfer unit in the transfer direction and before the trailing edge of the precedent sheet reaches the downstream end of the suction transfer unit. This makes it possible to further reduce a decrease in productivity while reducing sheet deterioration.

## BRIEF DESCRIPTION OF DRAWINGS

FIG. **1** is a schematic configuration diagram of a printing machine according to a first embodiment.

FIG. **2** is a control block diagram of the printing machine according to the first embodiment.

FIG. **3** is a view showing the relationship between paper types and set air flow rates of a fan.

FIG. **4** is a flowchart showing the control of the air flow rate of the fan according to the first embodiment.

FIG. **5**(*a*) is a timing diagram for the control of the air flow rate of the fan according to a comparative example, and FIG. **5**(*b*) is a timing diagram for an example of the control of the air flow rate of the fan according to the first embodiment.

FIG. **6** is a view showing the relationship between paper type combinations of a precedent sheet and a subsequent sheet and timings of the change of the air flow rate of the fan according to a second embodiment.

FIG. **7** is a flowchart showing the control of the air flow rate of the fan according to the second embodiment.

FIG. **8** is a timing diagram for an example of the control of the air flow rate of the fan according to the second embodiment.

FIG. **9** is a timing diagram for another example of the control of the air flow rate of the fan according to the second embodiment.

## DETAILED DESCRIPTION

In the following detailed description, for purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the disclosed embodiments. It will be apparent, however, that one or more embodiments may be practiced without these specific details. In other instances, well-known structures and devices are schematically shown in order to simplify the drawing.

Moreover, embodiments described below are intended to show examples of devices and the like for implementing technical principles of the invention, and the technical principles of the invention do not limit the arrangement of components and the like to ones described below. The technical principles of the invention can be variously modified within the scope of the appended claims.

### First Embodiment

FIG. **1** is a schematic configuration diagram of a printing machine according to a first embodiment of the present invention, and FIG. **2** is a control block diagram of the printing machine shown in FIG. **1**. In the description below, the direction of the front of the drawing of FIG. **1**, in which a user is positioned, is defined as front. Moreover, as shown in FIG. **1**, up, down, right, and left directions as seen by the user are defined as up, down, right and left directions.

In FIG. **1**, routes represented by bold lines are transfer routes along which paper P as a print medium is transferred. Of the transfer routes, the route represented by a solid line is a common route RC, the route represented by a dashed dotted line is a reversing route RR, the route represented by a broken line is a paper discharge route RD, and the route represented by two-dot chain lines is a paper supply route RS. The words upstream and downstream in the description below mean upstream and downstream of a transfer route, respectively.

As shown in FIGS. **1** and **2**, a printing machine **1** according to the first embodiment includes a paper feed unit **2**, a transfer and print unit **3**, an upside transfer unit **4**, a paper discharge unit **5**, a reversing unit **6**, a controller **7**, and a casing **8** for housing or holding each component.

The paper feed unit **2** feeds paper P. The paper feed unit **2** is arranged at the upstream end of the transfer routes. The paper feed unit **2** includes an external paper feed tray **11**, external paper feed rollers **12**, plural internal paper feed trays **13**, plural internal paper feed rollers **14**, plural pairs of vertical transfer rollers **15**, an external paper feed motor **16**, an internal paper feed motor **17**, registration rollers **18**, and a registration motor **19**.

The external paper feed tray **11** is configured to hold a stack of paper P for printing. The external paper feed tray **11** is installed such that part thereof is exposed outside the casing **8**.

The external paper feed rollers **12** pickup sheets of paper P one by one from the external paper feed tray **11** and transfer the paper P toward the registration rollers **18** along the paper supply route RS. The external paper feed rollers **12** are arranged above the external paper feed tray **11**.

The internal paper feed trays **13** are configured to hold stacks of paper P for printing. The internal paper feed trays **13** are arranged inside the casing **8**.

Each of the internal paper feed rollers **14** picks up sheets of paper P one by one from the internal paper feed trays **13** and send the paper P into the paper supply route RS. The internal paper feed rollers **14** are arranged above the internal paper feed trays **13**, respectively.

The vertical transfer rollers **15** transfer the paper P picked up from the internal paper feed trays **13** toward the registration rollers **18**. The vertical transfer rollers **15** are arranged along the paper supply route RS.

The external paper feed motor **16** rotationally drives the external paper feed rollers **12** and the most downstream vertical transfer rollers **15**. The external paper feed motor **16** is connected to the external paper feed rollers **12** and the most downstream vertical transfer rollers **15** through unillustrated one-way clutches, respectively. Thus, when the external paper feed motor **16** rotates in one direction, the external paper feed rollers **12** are driven, and when the external paper feed motor **16** rotates in the other direction, the most downstream vertical transfer rollers **15** are driven.

The internal paper feed motor **17** rotationally drives the internal paper feed rollers **14** and other vertical transfer rollers **15** than the most downstream vertical transfer rollers **15**. The internal paper feed motor **17** can be connected to and disconnected from the internal paper feed rollers **14** and the other vertical transfer rollers **15** through unillustrated clutches. With the clutches, the internal paper feed rollers **14** and the vertical transfer rollers **15** to be rotationally driven are switched.

The registration rollers **18** stops paper P transferred from the external paper feed rollers **12**, the vertical transfer rollers **15**, or undermentioned paper re-feed rollers **48** once, and then transfers the paper P toward the transfer and print unit **3**. The registration rollers **18** are arranged in the vicinity of a junction of the paper supply route RS and the reversing route RR on the common route RC.

The registration motor **19** rotationally drives the registration rollers **18**.

The transfer and print unit **3** prints an image on the fed paper P while transferring the paper P. The transfer and print unit **3** is arranged downstream of the paper feed unit **2**. The transfer and print unit **3** includes a belt transfer unit (suction transfer unit) **21**, an encoder **22**, an inkjet head unit **23**, and a paper sensor **24**.

The belt transfer unit **21** transfers the paper P fed by the paper feed unit **2**, with the paper P attached by suction onto a transfer surface **31***a*. The belt transfer unit **21** is arranged downstream of the registration rollers **18**. The belt transfer unit **21** includes a conveyor belt **31**, a driving roller **32**, driven rollers **33**, **34**, and **35**, a belt motor **36**, and a fan **37**.

The conveyor belt **31** is a looped belt passed over the driving roller **32** and the driven rollers **33** to **35**. The conveyor belt **31** has multiple belt holes, which are through holes for holding by suction the paper P. The conveyor belt **31** holds by suction the paper P onto the transfer surface (upper surface) **31***a* by a suction force generated in belt holes by driving the fan **37**. The conveyor belt **31** is rotated in a clockwise direction in FIG. **1** by driving the driving roller **32**, thus transferring the paper P held by suction onto the transfer surface **31***a* to the right. The transfer surface **31***a* is the upper surface of the conveyor belt **31** which is an approximately horizontal surface between the driving roller **32** and the driven roller **35**.

The driving roller **32** and the driven rollers **33** to **35** are components over which the conveyor belt **31** is passed. The driving roller **32** causes the conveyor belt **31** to rotate. The driven rollers **33** to **35** are driven by the driving roller **32** via the conveyor belt **31**.

The driven roller **33** is arranged a prescribed distance away from the driving roller **32** to the left of the driving roller **32** at approximately the same height as the driving roller **32**. The driven rollers **34** and **35** are arranged a prescribed distance away from each other in the right-left direction at approximately the same height below the driving roller **32** and the driven roller **33**.

The belt motor **36** rotationally drives the driving roller **32**.

The fan **37** produces a downward airflow. Thus, the fan **37** draws out air through the belt holes in the transfer surface **31***a* of the conveyor belt **31** to create negative pressures in the belt holes, thus attaching by suction the paper P onto the transfer surface **31***a*. The fan **37** is arranged in a space surrounded by the conveyor belt **31** passed over the driving roller **32** and the driven rollers **33** to **35**.

The encoder **22** outputs a pulse signal every time the driven roller **33** rotates by a prescribed angle.

The inkjet head unit **23** includes a line-type inkjet head having plural nozzles arranged in a direction (front-back direction) approximately perpendicular to the direction of transfer of paper P. The inkjet head unit **23** is arranged above the belt transfer unit **21**. The inkjet head unit **23** prints an image on paper P which is being transferred by the belt transfer unit **21**, by ejecting ink from the inkjet head.

The paper sensor **24** detects the paper P which is being transferred, at a position corresponding to the downstream end of the belt transfer unit **21** in the transfer direction. The paper sensor **24** is made of an optical sensor including light-emitting elements and light-receiving elements.

The upside transfer unit **4** transfers paper P received from the belt transfer unit **21** to the right and then to the left such that the paper P makes a U turn. The upside transfer unit **4** corresponds to part of a transfer and paper discharge unit. The upside transfer unit **4** includes plural pairs of upside transfer rollers **39** and plural motors (not shown) configured to rotationally drive the plural pairs of upside transfer rollers **39**.

The upside transfer rollers **39** transfers paper P while nipping the paper P. The most downstream pair of upside transfer rollers **39** are arranged upstream of the reversing route RR. The other upside transfer rollers **39** are arranged along the common route RC between the transfer and print unit **3** and the paper discharge unit **5**.

The paper discharge unit **5** discharges printed paper P transferred from the upside transfer unit **4**. The paper discharge unit **5** corresponds to part of the transfer and paper discharge unit. The paper discharge unit **5** includes a switching unit **41**, paper discharge rollers **42**, a paper discharge sensor **43**, a paper receiving tray **44**, a solenoid (not shown) configured to drive the switching unit **41**, and a motor (not shown) configured to rotationally drive the paper discharge rollers **42**.

The switching unit **41** switches the transfer route of paper P between the paper discharge route RD and the reversing route RR. The switching unit **41** is arranged at a point where the paper discharge route RD and the reversing route RR branch off.

The paper discharge rollers **42** transfer paper P guided to the paper discharge route RD by the switching unit **41** to discharge the paper P to the paper receiving tray **44**. The paper discharge rollers **42** are arranged on the paper discharge route RD between the switching unit **41** and the paper receiving tray **44**.

The paper discharge sensor **43** detects paper P to be discharged to the paper receiving tray **44**. The paper discharge sensor **43** is arranged between the paper discharge rollers **42** and the paper receiving tray **44**. The paper discharge sensor **43** is made of an optical sensor including light-emitting elements and light-receiving elements.

The paper receiving tray **44** is configured to hold a stack of discharged paper P. The paper receiving tray **44** is arranged at the downstream end of the paper discharge route RD.

The reversing unit **6**, in double-sided printing, reverses paper P printed on one side thereof, and transfers the paper P to the registration rollers **18**. The reversing unit **6** includes reversing rollers **46**, a switchback unit **47**, paper re-feed rollers **48**, a switching gate **49**, a motor (not shown) configured to rotationally drive the reversing rollers **46**, and a motor (not shown) configured to rotationally drive the paper re-feed rollers **48**.

The reversing rollers **46** temporarily carry paper P transferred from the upside transfer unit **4**, into the switchback unit **47**, and then move the paper P out to transfer the paper P to the paper re-feed rollers **48**. The reversing rollers **46** are arranged on the reversing route RR between the most downstream pair of upside transfer rollers **39** and an entrance of the switchback unit **47**.

The switchback unit **47** is a space into which the reversing rollers **46** temporarily carry paper P. The switchback unit **47** is formed in a lower portion of the paper receiving tray **44**. The switchback unit **47** has an opening in the vicinity of the reversing rollers **46** so that paper P may be carried into the switchback unit **47**.

The paper re-feed rollers **48** transfers paper P transferred from the reversing rollers **46**, to the registration rollers **18**. The paper re-feed rollers **48** are arranged on the reversing route RR between the reversing rollers **46** and the registration rollers **18**.

The switching gate **49** guides paper P transferred from the upside transfer rollers **39**, to the reversing rollers **46**. Moreover, the switching gate **49** guides paper P to be moved out of the switchback unit **47** by the reversing rollers **46**, to the paper re-feed rollers **48**. The switching gate **49** is arranged in the vicinity of the centroid of three points corresponding to the most downstream pair of upside transfer rollers **39**, the reversing rollers **46**, and the paper re-feed rollers **48**.

The controller **7** controls the operation of each unit of the printing machine **1**. The controller **7** is configured to include a CPU, a RAM, a ROM, a hard disk drive, and the like.

The controller **7** controls the suction force of the belt transfer unit **21** in accordance with the type of paper in a printing operation. The controller **7** controls the suction force of the belt transfer unit **21** by controlling the air flow rate of the fan **37**. The higher the air flow rate of the fan **37**, the stronger the suction force of the belt transfer unit **21**. In the case where the controller **7** changes the suction force of the belt transfer unit **21** between successive sheets of paper, the controller **7** performs control so that the change of the suction force of the belt transfer unit **21** and the feed of the subsequent sheet of paper by the paper feed unit **2** may be performed before the precedent sheet of paper P is discharged.

Next, the operation of the printing machine **1** will be described.

When the printing machine **1** starts a printing operation, unprinted paper P transferred from any one of the external paper feed tray **11** and the plural internal paper feed trays **13** of the paper feed unit **2** along the paper supply route RS is transferred to the transfer and print unit **3** by the registration rollers **18**. In the transfer and print unit **3**, the paper P is printed using ink ejected from the inkjet head unit **23** while being transferred by the belt transfer unit **21**.

In the case of single-sided printing, paper P printed on one side thereof is transferred from the belt transfer unit **21** to the upside transfer unit **4** to be transferred by the upside transfer rollers **39** of the upside transfer unit **4**, and is then guided to the paper discharge route RD by the switching unit **41**. After that, the paper P is discharged to the paper receiving tray **44** by the paper discharge rollers **42**.

In the case of double-sided printing, paper P printed on a front side thereof is transferred by the upside transfer rollers **39** of the upside transfer unit **4**, and is then guided to the reversing route RR by the switching unit **41**. In the reversing unit **6**, the paper P guided to the reversing route RR is guided to the reversing rollers **46** by the switching gate **49** and carried into the switchback unit **47** by the reversing rollers **46**. After that, the paper P is moved out of the switchback unit **47** by the reversing rollers **46** and guided to the paper re-feed rollers **48** by the switching gate **49**. Further, the paper P is transferred to the registration rollers **18** by the paper re-feed rollers **48**. Subsequently, the paper P is sent into the transfer and print unit **3** by the registration rollers **18**. Here, since the paper P is reversed by the reversing unit **6**, an unprinted side (back side) thereof is faced toward the inkjet head unit **23**. In the transfer and print unit **3**, the paper P is printed on a back side thereof using ink ejected from the inkjet head unit **23** while being transferred by the belt transfer unit **21**. The paper P printed on both sides thereof is discharged to the paper receiving tray **44** as in the above-described single-sided printing. Here, the side of paper P which is printed first is referred to as a front side, and the side of paper P which is printed later is referred to as a back side.

In the case where plural sheets of paper are printed, the sheets of paper P are sequentially fed from the paper feed unit **2** to be printed and discharged.

In a printing operation, the controller **7** controls the suction force of the belt transfer unit **21** in accordance with the type of paper by controlling the air flow rate of the fan **37**. FIG. **3** shows the relationship between paper types and set air flow rates of the fan **37**. In the case of ordinary or thick paper (indicated by TK in FIGS. **5**(*a*), **5**(*b*), **8**, and **9**), the air flow rate is "high" to generate a suction force capable of preventing floating from the transfer surface **31***a*. In the case of thin paper (indicated by TN in FIGS. **5**(*a*), **5**(*b*), **8**, and **9**), floating from the transfer surface **31***a* is less prone to occur than in the case of ordinary or thick paper, but wrinkles may occur in the paper when the suction force is too strong. Accordingly, the air flow rate is "low."

In the printing machine **1**, different types of sheets of paper which have different set air flow rates of the fan **37** may be successively fed and printed. For example, in the case where a print job in which thick paper and thin paper are used as print paper in a mixed manner is executed, there arises a situation in which thick paper and thin paper which have different set air flow rates of the fan **37** are successively fed and printed. An example of such a print job is a binding printing job in which thick paper and thin paper are used as paper for cover pages and paper for body pages, respectively. In such a case, the air flow rate of the fan **37** needs to be changed during a plural-sheet printing operation.

The control of the air flow rate of the fan **37** in a printing operation will be described with reference to a flowchart of FIG. **4**. Here, the case of single-sided printing will be described.

A process shown in the flowchart of FIG. **4** is started by submitting a print job to the controller **7**. When the print job is submitted, the controller **7** actuates the fan **37** in step S**1** of FIG. **4**. At this time, the controller **7** drives the fan **37** at the air flow rate corresponding to the paper type of a first sheet to be used in printing based on the print job.

Then, in step S**2**, the controller **7** controls the paper feed unit **2** so that the first sheet P may be fed from the registration rollers **18** to the transfer and print unit **3**.

Subsequently, in step S**3**, the controller **7** determines based on the print job whether or not there is a subsequent sheet to be fed.

If the controller **7** determines that there is a subsequent sheet (step S**3**: YES), the controller **7** determines in step S**4** based on the paper types of the most recently fed sheet P and the subsequent sheet P whether or not the air flow rate of the fan **37** needs to be changed for the subsequent sheet P from the current air flow rate.

If the controller **7** determines that the air flow rate of the fan **37** does not need to be changed (step S**4**: NO), the controller **7** causes the subsequent sheet P to be fed from the registration rollers **18** to the transfer and print unit **3** in step S**2**. At this time, the controller **7** controls the timing of paper feed so that the distance between the most recently fed sheet P and the subsequent sheet P may have a preset value.

If the controller **7** determines that the air flow rate of the fan **37** needs to be changed (step S**4**: YES), the controller **7** determines in step S**5** whether or not the trailing edge (upstream edge) of the most recently fed sheet P reaches the downstream end of the belt transfer unit **21**. Specifically, the controller **7** determines whether or not the paper sensor **24** detects the trailing edge of the most recently fed sheet P. It should be noted that the controller **7** may determine, based on the number of pulses outputted from the encoder **22** after the leading edge of the most recently fed sheet P reaches the upstream end of the belt transfer unit **21**, whether or not the trailing edge of the most recently fed sheet P reaches the downstream end of the belt transfer unit **21**.

If the controller **7** determines that the trailing edge of the most recently fed sheet P does reach the downstream end of the belt transfer unit **21** (step S**5**: NO), the controller **7** repeats step S**5**.

If the controller **7** determines that the trailing edge of the most recently fed sheet P reaches the downstream end of the belt transfer unit **21** (step S**5**: YES), the controller **7** changes the air flow rate of the fan **37** to the air flow rate corresponding to the subsequent sheet P in step S**6**. Then, the controller **7** causes the subsequent sheet P to be fed from the registration rollers **18** to the transfer and print unit **3** in step S**2**.

If the controller **7** determines in step S**3** that there is no subsequent sheet P (step S**3**: NO), the controller **7** determines in step S**7** whether or not all of fed sheets of paper P have left the belt transfer unit **21**. Here, when the controller **7** determines that the trailing edge of the most recently fed sheet P reaches the downstream end of the belt transfer unit **21**, the controller **7** determines that all of fed sheets of paper P have left the belt transfer unit **21**. The determination as to whether or not the trailing edge of the most recently fed sheet P reaches the downstream end of the belt transfer unit **21** is made as in the aforementioned step S**5**.

If the controller **7** determines that one or more of the fed sheets of paper P have not left the belt transfer unit **21** (step S**7**: NO), the controller **7** repeats step S**7**.

If the controller **7** determines that all of the fed sheets of paper P have left the belt transfer unit **21** (step S**7**: YES), the controller **7** stops the fan **37** in step S**8**. Thus, the control of the air flow rate of the fan **37** is ended.

Next, an example of the control of the air flow rate according to the above-described process shown in the flowchart of FIG. **4** will be described with reference to timing diagrams of FIGS. **5**(*a*) and **5**(*b*). FIGS. **5**(*a*) and **5**(*b*) show the control of the air flow rate for the case where plural copies of a document including two thin sheets and one thick sheet are printed on one side of each sheet. Here, FIG. **5**(*a*) shows the control of the air flow rate of a fan in a conventional printing machine as a comparative example, and FIG. **5**(*b*) shows the control of the air flow rate according to the process shown in the flowchart of FIG. **4**.

In each of FIGS. **5**(*a*) and **5**(*b*), a top row indicates the state, on/off, of the registration motor **19**. After a sheet of paper P sent to the registration rollers **18** from the upstream side touches the registration rollers **18**, the registration motor **19** is turned on to rotationally drive the registration rollers **18**. Then, immediately after the registration rollers **18** sends the sheet of paper P into the belt transfer unit **21**, the registration motor **19** is turned off. Thus, the registration motor **19** is driven briefly for each sheet.

In each of FIGS. **5**(*a*) and **5**(*b*), a second row from the top indicates the state, on/off, of the paper sensor **24**. The paper sensor **24** remains turned on during a period in which a sheet of paper P is passing the downstream end of the belt transfer unit **21** as a detection position; otherwise, the paper sensor **24** remains turned off.

In each of FIGS. **5**(*a*) and **5**(*b*), a third row from the top indicates the state, on/off, of the paper discharge sensor **43**. The paper discharge sensor **43** remains turned on during a period in which a sheet of paper P is passing a downstream end portion of the paper discharge route RD as a detection position; otherwise, the paper discharge sensor **43** remains turned off.

In each of FIGS. **5**(*a*) and **5**(*b*), a bottom row indicates whether the air flow rate of the fan **37** is "high" or "low."

In FIG. **5**(*a*), after time t1 when the trailing edge of a thin second sheet for a first copy passes the paper discharge sensor **43**, the air flow rate of the fan **37** is changed from "low" for thin paper to "high" for thick paper at time t2. After the change of the air flow rate, at time t3, the registration motor **19** starts to be driven, and a thick third sheet for the first copy is fed from the registration rollers **18** to the belt transfer unit **21**. Then, after time t4 when the trailing edge of the thick sheet for the first copy passes the paper discharge sensor **43**, the air flow rate of the fan **37** is changed from "high" to "low" at time t5. After the change of the air flow rate, at time t6, the registration motor **19** starts to be driven, and a thin first sheet for a second copy is fed from the registration rollers **18** to the belt transfer unit **21**. After that, similar control is repeated.

As described above, in the example of FIG. **5**(*a*), when the air flow rate of the fan **37** is changed between successive sheets, the air flow rate is changed after the precedent sheet is discharged, and then the subsequent sheet is fed.

On the other hand, in FIG. **5**(*b*), when the trailing edge of a thin second sheet for a first copy reaches the paper sensor **24** at time t11, the air flow rate of the fan **37** is changed from "low" to "high" at time t12 immediately after time t11. After the change of the air flow rate, the registration motor **19** starts to be driven at time t13, and a thick sheet for the first copy is fed from the registration rollers **18** to the belt transfer unit **21**. Then, immediately after the trailing edge of the thick sheet for the first copy reaches the paper sensor **24** at time t14, the air flow rate of the fan **37** is changed from "high" to "low" at time t15 immediately after time t14. After the change of the air flow rate, the registration motor **19** starts to be driven at time t16, and a thin first sheet for a second copy is fed from the registration rollers **18** to the belt transfer unit **21**. After that, similar control is repeated.

As described above, in FIG. **5**(*b*), when the air flow rate of the fan **37** is changed between successive sheets, the air flow rate is changed immediately after the trailing edge of the precedent sheet leaves the belt transfer unit **21**, before the precedent sheet is discharged, and then the subsequent sheet is fed.

Accordingly, in FIG. **5**(*b*), printing time is shortened, and productivity is improved, compared to those in FIG. **5**(*a*).

Specifically, for each change of the air flow rate, printing time can be shortened by time T required to transfer a sheet of paper P from the paper sensor **24** to the paper discharge sensor **43**. In other words, the length of time from the start of printing to time t17 when the trailing edge of the thick sheet for the first copy passes the paper discharge sensor **43** in FIG. **5**(*b*) is shorter by T than the length of time from the start of printing to time t4 when the trailing edge of the thick sheet for the first copy passes the paper discharge sensor **43** in FIG. **5**(*a*). Moreover, the length of time from the start of printing to time t18 when the trailing edge of the thick sheet for the second copy passes the paper discharge sensor **43** in FIG. **5**(*b*) is shorter by 3 T than the length of time from the start of printing to time t7 when the trailing edge of the thick sheet for the second copy passes the paper discharge sensor **43** in FIG. **5**(*a*).

Here, it is assumed that the length of time in the change of the air flow rate in FIG. **5**(*a*) from the time when the trailing edge of a precedent sheet passes the paper discharge sensor **43** to the time when the air flow rate is changed and the length of time in the change of the air flow rate in FIG. **5**(*b*) from the time when the trailing edge of a precedent sheet passes the paper sensor **24** to the time when the air flow rate is changed are the same. In other words, it is assumed that the lengths of time between times t1 and t2 and between times t4 and t5 in FIG. **5**(*a*) are the same as the lengths of time between times t11 and t12 and between times t14 and t15 in FIG. **5**(*b*), respectively. Moreover, it is assumed that the length of time from the time when the air flow rate is changed to the time when the registration motor **19** starts to be driven for the feed of a subsequent sheet is the same between FIGS. **5**(*a*) and **5**(*b*). In other words, it is assumed that the lengths of time between times t2 and t3 and between times t5 and t6 in FIG. **5**(*a*) are the same as the lengths of time between times t12 and t13 and between times t15 and t16 in FIG. **5**(*b*), respectively.

As described above, in the printing machine **1**, in the case where the air flow rate of the fan **37** is changed between successive sheets, the change of the air flow rate and the feed of the subsequent sheet are performed before the precedent sheet is discharged. Thus, the printing machine **1** can reduce a decrease in productivity.

It should be noted that, though in the example of FIG. **5**(*b*) the air flow rate is changed after the trailing edge of the precedent sheet reaches the paper sensor **24**, the air flow rate may be changed at the time when the trailing edge of the precedent sheet reaches the paper sensor **24**. This makes it possible to further shorten the distance between the precedent sheet and the subsequent sheet. As a result, a decrease in productivity can be further reduced.

Moreover, though in the example of FIG. **5**(*b*) the registration motor **19** starts to be driven after the air flow rate is changed, the timing of paper feed may be controlled such that the leading edge of the subsequent sheet may enter the belt transfer unit **21** (reach the upstream end of the belt transfer unit **21**) at the time when the air flow rate is changed.

In the above description of the control of the air flow rate of the fan **37** in a printing operation, the case of single-sided printing has been described. However, even in the case of double-sided printing, the control of the air flow rate similar to that for the case of single-sided printing can be performed.

For example, in the case where plural copies of a document including two thin sheets and one thick sheet as in FIGS. **5**(*a*) and **5**(*b*) are printed on both sides of each sheet, the controller **7** changes the air flow rate of the fan **37** from "low" to "high" after printing is performed on the back side of a thin second sheet for a certain copy and immediately after the trailing edge of the thin second sheet passes the downstream end of the belt transfer unit **21**, and causes a thick sheet to be fed. Moreover, after printing is performed on the back side of the thick sheet and immediately after the trailing edge of the thick sheet passes the downstream end of the belt transfer unit **21**, the controller **7** changes the air flow rate of the fan **37** from "high" to "low," and causes a thin first sheet for a subsequent copy to be fed.

## Second Embodiment

A printing machine according to a second embodiment has the same configuration as the printing machine **1** of the first embodiment except for the control of the air flow rate of the fan **37** between successive sheets. Accordingly, in the second embodiment, FIGS. **1** and **2** are also used.

In the second embodiment, in the case where the air flow rate of the fan **37** is changed between successive sheets, the controller **7** controls the timing of change of the air flow rate in accordance with the combination (paper type combination) of the precedent sheet and the subsequent sheet in paper type and paper size.

Specifically, if the paper type combination of the precedent sheet and the subsequent sheet is a prescribed combination, the controller **7** changes the air flow rate of the fan **37** in a period after the leading edge of the precedent sheet reaches the downstream end of the belt transfer unit **21** and before the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**. If the paper type combination is other than the prescribed combination, the controller **7** changes the air flow rate of the fan **37** immediately after the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**.

FIG. **6** shows one example of the relationship between the paper type combination of a precedent sheet and a subsequent sheet and the timing for changing the air flow rate of the fan **37**.

The paper type combination shown in a top row of FIG. **6** is referred to as a first combination. The first combination is the combination of a thick or ordinary precedent sheet of any size and a thin subsequent sheet of any size. The paper type combination shown in a middle row of FIG. **6** is referred to as a second combination. The second combination is the combination of a thin precedent sheet of a large size and a thick or ordinary subsequent sheet of any size. The paper type combination shown in a bottom row of FIG. **6** is referred to as a third combination. The third combination is the combination of a thin precedent sheet of a small size and a thick or ordinary subsequent sheet of any size. Here, for example, a small size means a size equal to or smaller than B5 size, and a large size means a size larger than B5 size.

In the case of the first combination, as shown in the top row of FIG. **6**, the timing for changing the air flow rate is the time when the amount of transfer reaches a reference value after the leading edge of a precedent sheet reaches the downstream end of the belt transfer unit **21**. As the reference value, a value set according to the paper size of the precedent sheet is used. Moreover, the reference value is a value smaller than the length of the precedent sheet in the transfer direction. In other words, in the case of the first combination, the air flow rate is changed in a period after the leading edge of the precedent sheet reaches the downstream end of the belt transfer unit **21** and before the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**.

For the first combination, the air flow rate of the fan **37** is changed from "high" to "low." Since the precedent sheet is a thick or ordinary sheet, the risk of a problem such as the occurrence of wrinkles in the precedent sheet is low even when the air flow rate is changed to "low" with part of the precedent sheet remaining on the transfer surface **31***a*. Accordingly, in the case of the first combination, the air flow rate is changed before the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**.

The reference value for the first combination is experimentally found in advance such that the sticking force of the precedent sheet to the transfer surface **31***a* can be maintained at a level large enough to prevent the sheet from being disturbed, even at the "low" air flow rate, from the time when the amount of transfer reaches the reference value after the leading edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**, to the time when the trailing edge of the precedent sheet passes the downstream end of the belt transfer unit **21**.

In the case of the second combination, as shown in the middle row of FIG. **6**, the timing for changing the air flow rate is the time when the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**.

For the second combination, the air flow rate of the fan **37** is changed from "low" to "high." Since the precedent sheet is a thin sheet of a large size, there is a risk of the occurrence of wrinkles in the precedent sheet when the air flow rate is changed to "high" with only a part of the precedent sheet remaining on the transfer surface **31***a*. Accordingly, in the case of the second combination, the air flow rate is changed at the time when the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**, i.e., at the time when the trailing edge of the precedent sheet leaves the belt transfer unit **21**.

In the case of the third combination, as shown in the bottom row of FIG. **6**, the timing for changing the air flow rate is the time when the amount of transfer reaches a reference value after the leading edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**. As similar to the reference value for the first combination, a value set according to the paper size of the precedent sheet is used as the reference value for the third combination. Moreover, the reference value for the third combination is a value smaller than the length of the precedent sheet with respect to the transfer direction. In other words, in the case of the third combination, the air flow rate is changed in a period after the leading edge of the precedent sheet reaches the downstream end of the belt transfer unit **21** and before the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**. Here, the reference value for the third combination is a value set separately from the reference value for the first combination.

For the third combination, the air flow rate of the fan **37** is changed from "low" to "high." The precedent sheet is a thin sheet but of a small size. Thus, the risk of a problem such as the occurrence of wrinkles in the precedent sheet is low even when the air flow rate is changed to "low" with part of the precedent sheet remaining on the transfer surface **31***a*. Accordingly, in the case of the third combination, the air flow rate is changed before the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**.

The reference value for the third combination is experimentally found in advance such that no wrinkles may occur in the precedent sheet partly remaining on the transfer surface **31***a*, even when the air flow rate is changed to "high" at the time when the amount of transfer reaches the reference value after the leading edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**. Here, even a thin sheet of a small size may have wrinkles if a portion of the sheet which remains on the transfer surface **31***a* when the air flow rate is changed to "high" has a too large area. Accordingly, the reference value for the third combination is set such that a portion of the precedent sheet which remains on the transfer surface **31***a* when the air flow rate is changed to "high" may have an area not allowing wrinkles to occur.

Next, the control of the air flow rate of the fan **37** in a printing operation according to the second embodiment will be described with reference to a flowchart of FIG. **7**. Here, the case of single-sided printing will be described.

A process shown in the flowchart of FIG. **7** is started by submitting a print job to the controller **7**. Processing of steps S**11** to S**14** in FIG. **7** is similar to the aforementioned processing of steps S**1** to S**4** in FIG. **4**.

If the controller **7** determines in step S**14** that the air flow rate of the fan **37** does not need to be changed (step S**14**: NO), the controller **7** determines in step S**15** whether or not the timing for changing the air flow rate is the time when the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**. Here, the controller **7** determines based on the paper type combination of the most recently fed sheet P and a subsequent sheet P whether or not the timing for changing the air flow rate is the time when the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**. Specifically, in the case of the second combination in FIG. **6**, the controller **7** determines that the timing for changing the air flow rate is the time when the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**. On the other hand, in the case of the first or third combination in FIG. **6**, the controller **7** determines that the timing for changing the air flow rate is not the time when the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**.

If the controller **7** determines that the timing for changing the air flow rate is the time when the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21** (step S**15**: YES), the controller **7** goes to step S**16**. On the other hand, if the controller **7** determines that the timing for changing the air flow rate is not the time when the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21** (step S**15**: NO), the controller **7** goes to step S**18**.

Processing of step S**16** is similar to the aforementioned processing of step S**5** in FIG. **4**. If the controller **7** determines in step S**16** that the trailing edge of the most recently fed sheet P reaches the downstream end of the belt transfer unit **21** (step S**16**: YES), the controller **7** immediately changes the air flow rate of the fan **37** to the air flow rate corresponding to the subsequent sheet P in step S**17**.

Then, the controller **7** causes the subsequent sheet P to be fed from the registration rollers **18** to the transfer and print unit **3** in step S**12**. Here, the controller **7** controls the timing of paper feed so that the leading edge of the subsequent sheet P may enter the belt transfer unit **21** (reach the upstream end of the belt transfer unit **21**) at the time when the air flow rate is changed.

In step S**18**, the controller **7** determines whether or not the leading edge of the most recently fed sheet P reaches the downstream end of the belt transfer unit **21**. Specifically, the controller **7** determines whether or not the paper sensor **24** has detected the leading edge of the most recently fed sheet P. It should be noted that the controller **7** may determine, based on the number of pulses outputted from the encoder **22** after the leading edge of the most recently fed sheet P reaches the upstream end of the belt transfer unit **21**, whether or not the leading edge of the most recently fed sheet P reaches the downstream end of the belt transfer unit **21**.

If the controller **7** determines that the leading edge of the most recently fed sheet P does not reach the downstream end of the belt transfer unit **21** (step S**18**: NO), the controller **7** repeats step S**18**.

If the controller **7** determines that the leading edge of the most recently fed sheet P reaches the downstream end of the belt transfer unit **21** (step S**18**: YES), the controller **7** determines in step S**19** whether or not the amount of transfer reaches the aforementioned reference value after the leading edge of the sheet P reaches the downstream end of the belt transfer unit **21**. Specifically, the controller **7** determines whether or not the number of pulses outputted from the encoder **22** after the leading edge of the sheet P reaches the downstream end of the belt transfer unit **21** reaches a value corresponding to the reference value for the amount of transfer. As the reference value, the reference value corresponding to any of the combinations is used, depending on whether the paper type combination of the most recently fed sheet P and the subsequent sheet P is the first or third combination.

If the controller **7** determines that the reference value is not reached yet (step S**19**: NO), the controller **7** repeats step S**19**.

If the controller **7** determines that the reference value is reached (step S**19**: YES), the controller **7** immediately changes the air flow rate of the fan **37** to the air flow rate corresponding to the subsequent sheet P in step S**20**.

Then, the controller **7** causes the subsequent sheet P to be fed from the registration rollers **18** to the transfer and print unit **3** in step S**12**. Here, the controller **7** controls the timing of paper feed so that the leading edge of the subsequent sheet P may enter the belt transfer unit **21** (reach the upstream end of the belt transfer unit **21**) at the time when the air flow rate is changed.

If the controller **7** determines in step S**13** that there is no subsequent sheet P (step S**13**: NO), the controller **7** goes to step S**21**. Processing of steps S**21** and S**22** is similar to the aforementioned processing of steps S**6** and S**7** in FIG. **4**. Thus, the control of the air flow rate of the fan **37** is ended.

Next, an example of the control of the air flow rate according to the above-described process shown in the flowchart of FIG. **7** will be described with reference to a timing diagram of FIG. **8**. FIG. **8** shows the control of the air flow rate for the case where plural copies of a document including two thin sheets and one thick sheet of a large size are printed on one side of each sheet.

In FIG. **8**, when the trailing edge of a thin second sheet for a first copy reaches the paper sensor **24** at time t21, the air flow rate of the fan **37** is changed from "low" to "high" at that time t21. This is the change of the air flow rate with the timing for the aforementioned second combination in FIG. **6**. Moreover, the driving of the registration motor **19** for transferring the thick third sheet is started before time t21 so that the leading edge of a thick sheet as a third sheet for a first copy may reach the upstream end of the belt transfer unit **21** at time t21.

After the change of the air flow rate, when the leading edge of the thick third sheet reaches the paper sensor **24** at time t22, the air flow rate of the fan **37** is changed from "high" to "low" at time t23 when the amount of transfer after that time t22 reaches the reference value. This is the change of the air flow rate with the timing for the aforementioned first combination in FIG. **6**. Moreover, the driving of the registration motor **19** for transferring the thin first sheet for the second copy is started before time t23 so that the leading edge of a thin first sheet for a second copy may reach the upstream end of the belt transfer unit **21** at time t23. After that, similar control is repeated.

Next, another example of the control of the air flow rate according to the above-described process shown in the flowchart of FIG. **7** will be described with reference to a timing diagram of FIG. **9**. FIG. **9** shows the control of the air flow rate for the case where plural copies of a document including two thin sheets and one thick sheet of a small size are printed on one side of each sheet.

In FIG. **9**, when the leading edge of a thin second sheet for a first copy reaches the paper sensor **24** at time t31, the air flow rate of the fan **37** is changed from "low" to "high" at time t32 when the amount of transfer after that time t31 reaches the reference value. This is the change of the air flow rate with the timing for the aforementioned third combination in FIG. **6**. Moreover, the driving of the registration motor **19** for transferring a thick third sheet for the first copy is started before time t32 so that the leading edge of the thick third sheet may reach the upstream end of the belt transfer unit **21** at time t32.

After the change of the air flow rate, when the leading edge of the thick third sheet reaches the paper sensor **24** at time t33, the air flow rate of the fan **37** is changed from "high" to "low" at time t34 when the amount of transfer after that time t33 reaches the reference value. This is the change of the air flow rate with the timing for the aforementioned first combination in FIG. **6**. Moreover, the driving of the registration motor **19** for transferring a thin first sheet for a second copy is started before time t34 so that the leading edge of the thin first sheet for the second copy may reach the upstream end of the belt transfer unit **21** at time t34. After that, similar control is repeated.

As described above, in the second embodiment, in the case where the paper type combination between a precedent sheet and a subsequent sheet is a prescribed combination, the controller **7** changes the air flow rate of the fan **37** in a period after the leading edge of the precedent sheet reaches the downstream end of the belt transfer unit **21** and before the trailing edge of the precedent sheet reaches the downstream end of the belt transfer unit **21**. This makes it possible to shorten the distance between the precedent sheet and the subsequent sheet while reducing sheet deterioration such as the occurrence of wrinkles. As a result, it becomes possible to further reducing a decrease in productivity while reducing sheet deterioration.

It should be noted that in the second embodiment, also, in the above description of the control of the air flow rate of the fan **37** in a printing operation, the case of single-sided printing has been described. However, as in the first embodiment, the control of the air flow rate similar to that for the case of single-sided printing can also performed in the case of double-sided printing.

## Other Embodiments

As described above, the present invention has been described based on the first and second embodiments. However, the descriptions and drawings constituting part of the present disclosure should not be construed as limiting the present invention. From the present disclosure, various alternative embodiments, examples, and practical techniques will be apparent to those skilled in the art.

In the above-described first and second embodiments, the printing machine **1** including the belt transfer unit **21** of an air suction type has been described. However, a configuration in which paper is transferred by another method may be employed. For example, a type in which paper is electrostatically attached to a charging belt to be transferred may be employed.

Embodiments of the present invention have been described above. However, the invention may be embodied in other specific forms without departing from the spirit or essential characteristics thereof. The present embodiments are therefore to be considered in all respects as illustrative and not restrictive, the scope of the invention being indicated by the appended claims rather than by the foregoing description and all changes which come within the meaning and range of equivalency of the claims are therefore intended to be embraced therein.

Moreover, the effects described in the embodiments of the present invention are only a list of optimum effects achieved by the present invention. Hence, the effects of the present invention are not limited to those described in the embodiment of the present invention.

What is claimed is:

**1**. A printing machine comprising:

a paper feed unit configured to feed a sheet of paper;

a suction transfer unit configured to transfer the sheet of paper fed by the paper feed unit in a transfer direction, with the sheet of paper being attached by suction onto a transfer surface;

a transfer and paper discharge unit configured to receive the sheet of paper from the suction transfer unit to transfer and discharge the sheet of paper; and

a controller configured to control a suction force of the suction transfer unit in accordance with a paper type,

wherein when the controller changes the suction force of the suction transfer unit between successive sheets of paper, the controller is configured prior to a discharge of a precedent sheet of paper to change the suction force of the suction transfer unit and drive the paper feed unit to feed a subsequent sheet of paper,

wherein when the controller changes the suction force of the suction transfer unit between the successive sheets of paper, and when the precedent sheet of paper and the subsequent sheet of paper are in a prescribed combination in the paper type and a paper size, the controller is configured to change the suction force of the suction transfer unit in a period after a leading edge of the precedent sheet of paper reaches the downstream end of the suction transfer unit in the transfer direction and before a trailing edge of the precedent sheet of paper reaches a downstream end of the suction transfer unit.

**2**. The printing machine according to claim **1**, wherein when the controller changes the suction force of the suction transfer unit between the successive sheets of paper, the controller is configured to change the suction force of the suction transfer unit at a time when a trailing edge of the precedent sheet of paper reaches a downstream end of the suction transfer unit in the transfer direction.

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